THE SOCIAL STATUS AND ITEMS OF PRODUCTIVITY IN THE DOMESTIC CHICKEN

by

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INTRODUCTION

The existence of social organization in flocks of chickens has been known since Schjelderup-Ebbe's (1922) investigations. Sanctuary's (1932) report indicated an association between position in the dominance order and items of productivity. Hens high in rank tended to produce more eggs than those low in the peck-order.

Further investigations by Masure and Allee (1934) and others, have confirmed these early observations, and led to detailed studies of social status and productivity items for hens. These studies have been of somewhat limited scope in terms of number of individuals, number of strains and breeds involved, and length of the productivity period under study.

The present investigation includes observations and measurements on 288 pullets from 150-360 days of age and involved six diverse strains of four breeds. One objective was to estimate further the association between social status of the individual and sexual maturity, egg production, initial body weight, gain in weight and rate of feeding. Another purpose was to investigate the possibility of social stability and inter-strain competition as factors which might cause certain strains when mixed with other strains to perform at relative levels different from those resulting when not in competition with other strains.

REVIEW OF LITERATURE

Since Schjelderup-Ebbe's early reports (1922, 1923, 1924) on the social hierarchy in chickens, many observers have verified his findings. It is now recognized that the peck-order forms the basis of all group behavior in adult chickens. Schjelderup-Ebbe (1922) reported observations on small groups of

two to twenty-five birds and on larger groups of 25-100 birds, and concluded that when more than ten hens are present, linear hierarchies are rare, and "triangular" relationships are common.

Masure and Allee (1934) substantiated Schjelderup-Ebbe's observations on the domestic fowl. Guhl (1953) found evidence of a peck-order in a flock of 96 White Rock hens. Fischel (1927) found that under range conditions, birds apparently formed loose social groups when away from the hen house, and that these groups were led by any hen. Guhl (1953) also suggested that under range conditions the peck-order of large groups may be less stable.

The effect of peck-order position on the individual's behavior has been reported by Sanctuary (1932), Masure and Allee (1934), Collias (1944) and Guhl (1953). High ranking birds have priority for food, nests and roosting places and have greater freedom of the pen. They also tend to produce more eggs than birds low in rank.

Guhl and Allee (1944) compared well integrated flocks with an established peck-order to flocks undergoing constant reorganization. It was found that generally the hens in the organized flocks pecked each other less, consumed more feed and produced more eggs than the groups undergoing reorganization. These results, which were obtained over a period of 13 months, indicate the value of social order to the flock as a whole and the necessity of social cohesion for good production.

Using 12 small flocks of one to two birds of each breed, Potter (1949) attempted to ascertain whether there were differences in social dominance among birds of seven different breeds. An analysis of variance of the ranks achieved by all hens in all flocks showed that the differences in ranks held by certain of the breeds were significant. That the recognition of individuals of other breeds as individuals may not be as notable as the recognition of

them as a breed type was also evident in Potter's work. Potter and Allee (1953) also found that a hen may respond to a member of another breed on the basis of breed recognition rather than one of individual recognition. Holabird (1955) observed that there are breed differences in aggressive behavior, thus confirming other workers' results.

Bellah (1957), using birds also involved in this experiment, compared aggressiveness in four breeds of eight-month-old hens. In staging initial pair-contests, ten randomly selected hens from pens of Black Australorp, Rhode Island Red, White Leghorn and White Plymouth Rock were used. Each of the ten birds of each breed met each of the 30 birds from the other three breeds in a neutral area. Bellah found that the Rhode Island Reds won 200 of 300 paired-contests. The White Rocks were found to be significantly more aggressive than the Black Australorps. All other comparisons were non-significant, as to the number of fights won or lost.

Recently, Jaap (personal communication) has compared several strains and breeds of birds for hen-housed egg production over a one year period. Essentially no difference was observed between intermingled and pure strain flocks although statistical tests were not employed.

MATERIALS AND METHODS

Six pure strains presumably resulting from closed flock selection for a number of generations were used. Four breeds were involved, including three strains of Single Combed White Leghorns (WL), and one strain each of Black Australorps (BA), Rhode Island Reds (RIR) and White Plymouth Rocks (WR).

All chicks were hatched and wingbanded April 4, 1956. The WR chicks were produced from randomly selected White Plymouth Rock parents of the Kansas State College strain. Hatching eggs of the other five strains were shipped

in from five prominent breeders who were asked to supply pure strain stock of high productivity. All chicks were sexed at hatching. The pullets were then mixed so that the different strains were represented in each brooder in proportion to the total number of each strain present at hatching. The chicks were raised in batteries until four weeks of age, then transferred to a brooder house. At eight weeks of age they were moved to the poultry range, with the exception of the "stable" population described below. The pullets were housed at five months of age.

The poultry house was divided into three "intermingled" pens (10'x 16') each of which held 48 birds with eight birds representing each of the six strains. The house also had six "pure strain" pens (8'x 10') each holding 24 pullets of the same strain. In all, there were 144 intermingled and 144 pure strain for a total of 288 birds.

With the exception of one pen of permanent construction and central location, all pens were randomly assigned to locations in the house. All nine pens were of similar construction, and arrangement of feeders, waterers and roosting and nesting areas was essentially the same within the pure and the intermingled pens. Adequate feeder and water space was provided throughout the experimental period to reduce competition effects from this source as much as possible.

The "stable" group originally consisted of 96 birds, with equal representation of the various strains, which were reared together from the time of hatching until the pullets were housed. Bellah (1957) found that this group was developing a peck-order by nine weeks of age. Forty-eight pullets from the 96 went into one of the three intermingled pens of the laying house with eight pullets being randomly selected from each strain. The two other intermingled flocks and all the pure strain flocks were considered as being

relatively "unstable" at time of housing since the pullets placed in them were range reared and in most cases were strangers to each other when housed. Each strain was randomly assigned to one of the pure strain pens in the house. Individuals of each strain were randomly assigned to pure strain or intermingled flocks by wingband number.

At housing, all birds were debeaked, weighed and identified by wing badges on both wings. Data on egg production for this study include the period September 13 through March 31. The birds were trapnested three days per week. Body weights were taken every 90 days, in September, December and March. Survivor's egg production, body weights, sexual maturity and gains in weight were used in correlating social status and productivity on a within strain basis. These items along with hen-housed egg production and mortality records were used in estimating whether competition effects might result in different relative performance of strains in intermingled flocks as compared with performance where strains were not mixed together.

As soon as the pullets were housed, they were observed for at least four hours per day, six days per week for the first two months in order to determine the "peck-order" in each of the nine pens. Feeding rates were obtained by observing each flock two hours per week in two one-hour periods, between 3 and 5 p.m., from September to December. At the beginning, middle and end of each hour observation period the badge numbers of the birds that were feeding were recorded. Fights, pecks and avoidances were all used in estimating the peck-order of each flock. Since these terms may vary as to meaning they are defined as follows for the purposes of this experiment:

Fighting——Involved pecking on the part of both individuals.

Pecking——Unidirectional pecking. One individual pecked another, causing the latter individual to give way. Peck was not contested.

Avoiding—One individual threatened, the other gave way by lowering its head or moving away.

Each social interaction between pairs of individuals was recorded with the dominant individual listed first and the submissive bird second.

Guhl (1953) working with a relatively large number (96 hens) ranked birds in the peck-order on the basis of the number of individuals pecked by each bird in the flock. In considering this method of ranking it was hypothesized that phlegmatic birds, which were actually high in the dominance order, might not be observed to interact with many other birds and yet would not themselves show submissive behavior. For this reason a modification in the method of ranking seemed desirable. In this experiment the modified method used to determine the rank of an individual "X" within a pen was based on the following: Percentile Rank = $(A + B)/2$, where:

A = the percentage of birds in the pen that X dominated (Guhl's method).

B = 1.00 minus the percentage of birds in the pen dominating X.

Correlation coefficients shown in Table 1 were obtained on a within pen basis, between Guhl's method (A) and the modified method of $(A + B)/2$ in determining the percentile rank of an individual. The high correlations (.90 and higher) between Guhl's method and the modified method used in this experiment, indicate that direct comparison of results from this experiment with results of his studies is justified. Correlation coefficients between social status and various items of productivity were calculated on a within flock, within strain basis, respectively. The method of chi-square described by Snedecor (1946) was used to test the hypothesis that the correlations from the same strain in different social organizations were heterogeneous and likewise that the correlations for the six strains were not alike. The average "z" value was used in determining an average correlation, where heterogeneity

was not found.

Table 1. Correlations between method A and the modified method in determining percentile rank.

Flocks	df	Correlation
Pure strain:		
Ghostley WL (GL)	22	.99**
Honegger WL (HL)	22	.99**
Dirksie WL (DL)	20	.91**
Berry BA (BA)	20	.93**
Parmenter RIR (PR)	17	.97**
KSC WR (WR)	20	.99**
Intermingled:		
Stable pen 1	44	.93**
Unstable pen 1	44	.90**
Unstable pen 2	40	.91**

** Significant at the .01 level

Snedecor's (1946) method, involving an R x 2 table with disproportionate subclass numbers, was used in running analyses of variance on the various items of productivity. The interaction term was tested by the mean square for individuals. If there was no interaction, the normal procedure was followed in computing the sum of squares for strains, with the exception that a correction for disproportion was subtracted from the preliminary sum of squares for strains. If interaction was present, then the method of weighted squares of means was followed. Using the above methods, an analysis of variance was run between the two unstable intermingled flocks. If interaction was not present, then the two flocks were pooled and an analysis of variance run between them and the stable intermingled population. Providing interaction was not present, an analysis of variance was then run between the pooled intermingled flocks and the pure strain flocks.

It should be emphasized that the strain by social-organization interaction term was of primary importance in this study. A non-significant interaction term was taken to mean that the strains were performing at the same

relative levels whether in stable or unstable intermingled flocks or whether in pure strain or intermingled groups. Contrarily, if interaction was present, it suggested that competition effects were involved, as the strains were not performing at the same relative levels in the different social organizations involved.

In running an analysis of variance for hen-housed egg production and percentage mortality, the interaction term is also the error term, since these traits are calculated with the strain social-organization subclasses as the units of measurement. Since the hypothesis that there is no strain by social-organization interaction is identical with the hypothesis of independence using chi-square in an R x C table (Snedecor, 1946) this method was used in testing for interaction in these two traits.

RESULTS

Social Status and Productivity of Individual Pullets

Correlations of within-flock percentile rank with various items of productivity for individual pullets within strains are given in Table 2. These average correlation coefficients were calculated after using Snedecor's (1946) chi-square method of r-z transformation in testing for heterogeneity of correlations between samples of the same strain in different pens and between different strains. Essentially no heterogeneity was found as only eight chi-square values were found to be significant in 105 comparisons, which is no more than might reasonably be expected due to chance. Highly significant, positive correlations were found to exist between percentile rank and initial weight in September, rate of feeding from September 10 to December 21 (103 days) and survivor's percentage egg production for the September 4 to December 31

period (119 days). Date of first egg was negatively correlated with percentile rank at a highly significant level ($P<.01$), i.e. birds maturing earlier tended to have higher social status. Gain in weight from September 4 to December 4 (92 days) was significantly ($P<.05$) and negatively correlated with percentile rank. There was no significant correlation between percentile rank and gain in weight for the September 4 to March 4 period (182 days) or for survivor's percentage egg production for the September 4 to April 1 period (209 days). The results in Table 2 therefore indicated a tendency within a pen for hens higher in the peck-order to be heavier, feed more often, mature earlier and to have higher egg production rates. They also tended to gain at a slightly lower rate than hens low in rank. The tendency for higher ranking birds to gain at a slower rate and to lay more eggs was much less pronounced when considering the longer period of September to March or to April, respectively, for these two traits.

Table 2. Correlations of within-pen percentile rank with various items of productivity for individuals within strains.

Items of Productivity	df	Positive r	Negative r
September weight	263	.54**	
Gain in weight (Sept.-Dec.)	263		-.13*
Gain in weight (Sept.-Mar.)	237		-.09
Feeding activity	263	.32**	
Sexual maturity	248		-.32**
Survivor's % egg production (Sept.-Dec.)	247	.24**	
Survivor's % egg production (Sept.-Apr.)	226	.10	

** Significant at the .01 level
 * Significant at the .05 level

Relative Productivity of Strains in Different Social Organizations

Social Rank (percentile). Analyses of variance (ANOVA) were run on percentile rank of the strains in the two intermingled unstable flocks and then with the

pooled unstable and stable intermingled flocks. The average percentile ranking of the six strains in stable and unstable intermingled flocks and the mean squares from the latter analysis are presented in Tables 3 and 4, respectively. In comparing the two unstable flocks, interaction was found to be non-significant, as would be expected. However, interaction was present when the stable and unstable intermingled flocks were compared, thus suggesting that the relative aggressiveness of intermingled strains differed, depending on how old the birds were when they were assembled.

Bellah (1957) using eight-month-old birds also involved in this experiment, staged initial pair-contests involving ten randomly selected hens from pure strain flocks of BA, PR, DL and WR. Each of the ten birds of each breed met each of the 30 birds from the three other breeds. Bellah found that the PR birds won 200 out of 300 initial pair-contests with strange birds of the three other breeds, although they were the least aggressive breed in intermingled flocks. It was suggested that in the case of the PR, a "maturing effect" may have been involved as the hens used in the initial pair-contests were eight months old, wheras the hens in the intermingled flocks were assembled at five months of age. The postulated maturing effect would presumably explain why the PR had a higher percentile ranking in the intermingled unstable flocks, which were assembled at five months of age, as compared to the stable flock, where the strains were reared together from time of hatching. Contrarily, the BA ranked high in the stable intermingled flock at 10 weeks of age (Bellah, 1957) but ranked fourth at five months of age in unstable intermingled flocks. At eight months of age the BA were the least aggressive of the four breeds involved in initial pair-contests (Bellah, 1957). This also suggests that the age at which strains are assembled influences the relative aggressiveness of the strains. Definite breed and strain differences

were present as indicated by the breakdown of strains sum of squares from the analysis of variance, Table 4.

Table 3. Average percentile ranking of the six strains in stable and unstable intermingled flocks.

Strains	Intermingled flocks Unstable	Stable	Difference (U-S)
White Leghorn:			
GL	.63	.55	.08
DL	.56	.59	-.03
HL	.43	.43	.00
Heavy breeds:			
WR	.56	.70	-.14
BA	.46	.58	-.12
PR	.29	.19	.10

Table 4. ANOVA of percentile rank between stable and unstable intermingled flocks.

Source of Variation	df	Sum of Squares	Mean Square
Stable vs Unstable flocks	1	.0108	.0108
Strains:	(5)	(1.9912)	(.3982)*
WL vs Heavy breeds	1	.1104	.1104
HL vs other WL	1	.3048	.3048
GL vs DL	1	.0032	.0032
PR vs other Heavy breeds	1	1.4480	1.4480**
WR vs BA	1	.1248	.1248
Interaction	5	.2480	.0496*
Individuals	116	2.1260	.0183

** Significant at the .01 level
* Significant at the .05 level

Initial Weight and Gains in Weight. Table 5 gives the average September weights of the different strains. Analyses of variance on September body weights between the stable and unstable intermingled flocks and then between the pooled intermingled and pure strain flocks resulted in a non-significant interaction term for both analyses, Tables 6 and 7, respectively. This was to be expected, as all the birds in unstable flocks were treated alike prior to housing.

Strains that were raised together from the time of hatching, and which later made up the intermingled stable flock, weighed more on the average than pullets that made up the unstable intermingled flocks; however, the difference was not quite large enough to be significant (F = 3.00). Definite strain differences in weight were present, as would be expected. Within the WL and heavy breeds, the strains that had a higher rank tended to weigh more, indicating a possible association between body weight and percentile rank.

Table 5. Average September weights of the different strains.

Strains	Percentile Rank (unstable pens)	September weight (in lbs.)
White Leghorn:		
GL	.63	3.2
DL	.56	3.2
HL	.43	2.9
Heavy breeds:		
WR	.56	4.1
BA	.46	4.0
PR	.29	3.8

Table 6. ANOVA of September weight between stable and unstable intermingled flocks.

Source of Variation	df	Sum of Squares	Mean Square
Social Organization	1	.4212	.4212
Strains:	(5)	(30.9612)	(6.1922)**
WL vs Heavy breeds	1	28.0400	28.0400**
HL vs other WL	1	1.3000	1.3000**
GL vs DL	1	.0300	.0300
PR vs other Heavy breeds	1	1.1700	1.1700**
WR vs BA	1	.4200	.4200
Interaction	5	.3420	.0684
Individuals	116	16.2800	.1403

** Significant at the .01 level

An ANOVA was run on gains in weight from September to December and September to March. For both periods a non-significant interaction was found when comparing the stable and unstable intermingled flocks, thus suggesting

that time of assembly had no effect on weight gains.

Table 7. ANOVA of September weight between intermingled and pure strain flocks.

Source of Variation	df	Sum of Squares	Mean Square
Social Organization	1	.0262	.0262
Strains:	(5)	(56.4362)	(11.29)**
WL vs Heavy breeds	1	51.77	51.77**
HL vs other WL	1	3.16	3.16**
GL vs DL	1	.01	.01
PR vs other Heavy breeds	1	1.12	1.12**
WR vs BA	1	.40	.40
Interaction	5	.5304	.1061
Individuals	243	31.67	.1303

** Significant at the .01 level

In comparing the pooled intermingled flocks with the pure strain flocks for gains in weight, a significant ($P<.05$) interaction was found for both periods, Tables 8 and 9. This would suggest that competition effects may have been involved. Examination of the gains made by the various strains, Table 10, indicates some tendency for less aggressive strains to do better in pure strain flocks as might be expected. The WR strain does not conform to expected results as it also gained better in the pure strain flock even though it was the most aggressive of the heavy breed strains.

Table 8. Mean squares from the gain in weight ANOVA between intermingled and pure strain flocks for the September to December period.

Source of Variation	df	Sum of Squares	Mean Square
Intermingled vs Pure strain	1	.0288	.0288
Strains:	(5)	(11.5636)	(2.3127)*
WL vs Heavy breeds	1	7.7208	7.7208**
Within WL	2	.0780	.0390
WR vs other Heavy breeds	1	3.5584	3.5584*
BA vs PR	1	.2068	.2068
Interaction	5	1.7930	.3586*
Individuals	243	38.37	.1579

** Significant at the .01 level
 * Significant at the .05 level

Table 9. Mean squares from the gain in weight ANOVA between intermingled and pure strain flocks for the September to March period.

Source of Variation	df	Sum of Squares	Mean Square
Intermingled vs Pure strain	1	.7128	.7128
Strains:	(5)	(23.2464)	(4.6493)*
WL vs Heavy breeds	1	18.4560	18.4560**
Within WL	2	.4600	.2300
PR vs other Heavy breeds	1	4.2788	4.2788
WR vs BA	1	.0516	.0516
Interaction	5	3.4206	.6841*
Individuals	217	61.54	.2836

** Significant at the .01 level
 * Significant at the .05 level

Table 10. Average gains in weight for each strain from September 4 to December 4 and September 4 to March 4.

Strains	Percentile Rank (unstable pens)	(Sept.-Dec.) Interm.	Pure	(I-P)	(Sept.-Mar.) Interm.	Pure	(I-P)
White Leghorn:							
GL	.63	1.0	.9	.1	1.3	1.0	.3
DL	.56	.9	1.0	-.1	1.2	1.2	.0
HL	.43	.9	1.0	-.1	.9	1.2	-.3
Heavy breeds:							
WR	.56	1.1	1.0	.1	1.4	1.7	-.3
BA	.46	1.4	1.3	.1	1.6	1.6	.0
PR	.29	1.3	1.6	-.3	1.8	2.2	-.4

Feeding Rates. The total number of times each bird was observed feeding from September 5 to December 1 (87 days) was recorded. The average feeding activity per bird for a particular strain was calculated after pooling the total feeding activity for all individuals within a strain, Table 11. These average values show a non-significant tendency for most of the strains to feed more often in the pure strain flocks. No interaction was found between the stable and unstable intermingled flocks indicating that time of assembly had no effect on feeding rates. However, a significant ($P<.01$) interaction was revealed when an ANOVA was run between the pooled intermingled and pure strain flocks, Table 12. This suggested that certain strains fed at

relatively different levels when in competition with other strains. The association, if any, with social rank of the strains is not clear (Table 11).

Table 11. Average feeding activity per bird for the six strains in intermingled and pure strain flocks.

Strains	Percentile Rank (unstable pens)	Intermingled	Pure	(I-P)
White Leghorn:				
GL	.63	17.8	13.7	4.1
DL	.56	15.7	15.8	-0.1
HL	.43	16.8	19.7	-2.9
Heavy breeds:				
WR	.56	13.0	17.4	-4.4
BA	.46	10.2	14.3	-4.1
PR	.29	14.0	16.6	-2.6

Table 12. Mean squares from the ANOVA on feeding activity for intermingled and pure strain flocks.

Source of Variation	df	Mean Square
Intermingled vs Pure	1	183.2
Strains	5	192.2
Interaction	5	113.7**
Individuals	243	31.2

** Significant at the .01 level

Sexual Maturity. The means for number of days to sexual maturity for the six strains are given in Table 13. When running an ANOVA between stable and unstable intermingled flocks and then between the pooled intermingled and pure strain flocks the interaction term was found to be non-significant. This indicated that the relative age at sexual maturity was not influenced by the social organization. Definite strain differences were found, as indicated by the detailed breakdown of the strain sum of squares in Table 14. Within the WL and within the heavy breeds, those strains that matured earlier tended to have a higher percentile rank.

Table 13. Average number of days to sexual maturity for the six strains.

Strain	Percentile Rank (unstable pens)	Average number of days to sexual maturity
White Leghorn:		
GL	.63	184
DL	.56	184
HL	.43	193
Heavy breeds:		
WR	.56	174
BA	.46	197
PR	.29	191

Table 14. ANOVA of sexual maturity involving pooled intermingled and pure strain flocks.

Source of Variation	df	Sum of Squares	Mean Square
Intermingled vs Pure	1	53	53
Strains:[1]	(5)	(13,609)	(2,721)**
WL vs Heavy breeds	1	42	42
HL vs other WL	1	2,515	2,515**
GL vs DL	1	1	1
WR vs other Heavy breeds	1	10,323	10,323**
BA vs PR	1	698	698
Interaction	5	218	44
Individuals	228	69,862	306

** Significant at the .01 level

[1] The sum of the individual sum of squares for strains does not quite equal the total sum of squares for strains (5 df) due to the correction for disproportion that was made.

Mortality. An ANOVA was run of percentage mortality, (Tables 15 and 16) from September 4 to December 31 (119 days) and from September 4 to June 15 (285 days). The interaction term, which was also the error term, was tested by chi-square to see if the interaction was significant (Snedecor, 1946). Chi-square values for both periods revealed no interaction when the stable and unstable intermingled flocks were compared. This suggested that it made no difference in percentage mortality as to when the strains were assembled. Considering the pooled intermingled and pure strain flocks for both periods, chi-square values indicated the absence of interaction for percentage mortality,

suggesting the absence of any competition effects. Definite strain differences in mortality were found for both periods, as indicated by Tables 15 and 16. Since the HL and PR had the highest mortality, Table 17, and were the least aggressive it is suggested that aggressiveness tends to have survival value.

Table 15. ANOVA of mortality between the pooled intermingled and pure strain flocks for the September 4 to December 31 period.

Source of Variation	df	Sum of Squares	Mean Square
Intermingled vs Pure	1	.0143	.0143
Strains:	(5)	(2.4678)	(.4936)**
WL vs Heavy breeds	1	.6942	.6942**
HL vs other WL	1	.7146	.7146**
GL vs DL	1	.0000	.0000
PR vs other Heavy breeds	1	.7834	.7834**
WR vs BA	1	.2756	.2756**
Interaction	5	.0715	.0143

** Significant at the .01 level

Table 16. ANOVA of mortality between the pooled intermingled and pure strain flocks for the September 4 to June 15 period.

Source of Variation	df	Sum of Squares	Mean Square
Intermingled vs Pure	1	.0921	.0921
Strains:	(5)	(4.3345)	(.8669)**
WL vs Heavy breeds	1	.00	.00
HL vs other WL	1	2.20	2.20**
GL vs DL	1	.23	.23*
PR vs other Heavy breeds	1	1.77	1.77**
WR vs BA	1	.13	.13
Interaction	5	.1272	.0254

** Significant at the .01 level
* Significant at the .05 level

Table 17. Average percentage mortality for the six strains from September 4 to December 31 and from September 4 to June 15.

Strains	Percentile Rank (unstable pens)	Percentage Mortality (all pens) Sept.-Dec. 31	Sept.-June 15
White Leghorn:			
GL	.63	.00	.19
DL	.56	.00	.10
HL	.43	.08	.44
Heavy breeds:			
WR	.56	.02	.12
BA	.46	.08	.19
PR	.29	.17	.42

Survivor's Percentage Egg Production. An ANOVA on survivor's percentage egg production from September 4 through December 31 (119 days) revealed no interaction between the two unstable intermingled flocks, as expected. When the pooled unstable intermingled flocks were compared with the stable intermingled flock a significant ($P<.05$) interaction was revealed, Table 18. This indicates that the age at which these strains were assembled influenced egg production rates, Table 19.

Table 18. ANOVA mean squares of survivor's percentage egg production for the September through December period.

Source of Variation	df	Mean Square
Unstable vs Stable interm.	1	.0612
Strains	5	.0482
Interaction	5	.0779*
Individuals	105	.0296

* Significant at the .05 level

Since there was an interaction between stable and unstable flocks, only the pooled unstable intermingled groups were compared with the pure strain flocks, Table 20. In this comparison, an interaction ($P=.05$) was also found, suggesting competition effects. Examination of Table 21 reveals that the socially low-ranking PR strain performed at a considerably higher rate in the

pure strain flock as compared to the unstable intermingled flocks. On the other hand, the most aggressive WL and heavy strains performed at higher levels in the intermingled flocks. This latter result is difficult to explain unless stimulation effects are postulated for these aggressive strains. However, the results follow expectation in that the less aggressive strains tended to perform at lower rates in intermingled flocks.

Table 19. Percentage egg production of survivors from September 4 through December 31 in stable and unstable intermingled flocks.

Strains	Percentile Rank (unstable pens)	Intermingled flocks Unstable	Stable	(U-S)
White Leghorn:				
GL	.63	.83	.75	.08
DL	.56	.66	.76	-.10
HL	.43	.70	.62	.08
Heavy breeds:				
WR	.56	.74	.55	.19
BA	.46	.78	.62	.16
PR	.29	.64	.77	-.13

Table 20. ANOVA mean squares of survivor's percentage egg production from September 4 through December 31 for the unstable intermingled vs pure strain flocks.

Source of Variation	df	Mean Square
Social Organization	1	.0180
Strains	5	.0778
Interaction	5	.0536 (*)
Individuals	190	.0237

(*) Just significant at the .05 level

Table 21. Percentage egg production of survivors from September 4 through December 31 in unstable intermingled and pure strain flocks.

Strains	Percentile Rank (unstable pens)	Unstable Interm.	Pure Strain	(IU-PS)
White Leghorn:				
GL	.63	.83	.76	.07
DL	.56	.66	.73	-.07
HL	.43	.70	.71	-.01
Heavy breeds:				
WR	.56	.74	.66	.08
BA	.46	.78	.81	-.03
PR	.29	.64	.78	-.14

An ANOVA on the September 4 to April 1 (209 days) period revealed no interaction for any of the ANOVA comparisons, Table 22. There did appear, however, to be some tendency for the less aggressive strains to show better performance in pure strain flocks for the longer period, Table 23. This suggests that over a longer period of time competition effects became less important, as the strains tended to adjust themselves to their particular social organization.

Table 22. ANOVA mean squares of survivor's percentage egg production from September 4 to April 1 in intermingled vs pure strain flocks.

Source of Variation	df	Mean Square
Intermingled vs Pure	1	.0402
Strains	5	.0496
Interaction	5	.0291
Individuals	206	.0310

Table 23. Percentage egg production of survivors from September 4 to April 1.

Strains	Percentile Rank (unstable pens)	Survivor's Percentage Egg Production		
		Pooled Interm.	Pure Strain	(I-P)
White Leghorn:				
GL	.63	.71	.69	.02
DL	.56	.69	.66	.03
HL	.43	.59	.65	-.06
Heavy breeds:				
WR	.56	.61	.61	.00
BA	.46	.64	.72	-.08
PR	.29	.61	.71	-.10

<u>Hen-housed Egg Production.</u> Chi-square analyses were carried out to determine whether strain by social organization interactions were present for the period September 4 to April 1. A significant chi-square value was found when comparing the two unstable intermingled flocks. Since these flocks were treated alike and there was no apparent explanation for such an interaction, other than chance, the results were pooled for further comparisons.

Comparison of the stable intermingled flock with the pooled unstable intermingled flocks also revealed a significant interaction. This indicated that certain of the strains were producing at relatively different levels in the stable and unstable intermingled flocks, Table 24. It is postulated that the

Table 24. Hen-housed egg production from September 4 to April 1 in stable and unstable intermingled flocks.

Strains	Percentile Rank (unstable pens)	Intermingled flocks Unstable	Stable	(U-S)
White Leghorn:				
GL	.63	53.5	50.1	3.4
DL	.56	50.0	60.2	-10.2
HL	.43	34.4	37.9	-3.5
Heavy breeds:				
WR	.56	45.5	24.4	21.1
BA	.46	41.3	40.5	.8
PR	.29	29.1	66.4	-37.3

less aggressive strains did better in the stable intermingled flock as compared to the unstable intermingled flocks because they were assembled five months earlier and thus became adjusted prior to the egg production period. This same explanation in part may serve for the results obtained with survivor's egg production as the PR strain did considerably better in the stable flock as compared to the unstable intermingled flocks. A significant ($P<.01$) chi-square value was also obtained when comparing the pooled unstable intermingled and pure strain flocks, Table 25. Within the WL and within the heavy breeds there was a clear tendency for the less aggressive strains to produce less eggs per bird-housed in intermingled flocks as compared to their performance in pure strain flocks, Table 26. An ANOVA revealed definite strain differences as indicated by the breakdown of the strain sum of squares in Table 25.

Table 25. ANOVA on hen-housed egg production from September 4 to April 1.

Source of Variation	df	Sum of Squares	Mean Square
Unstable Interm. vs Pure Strain	1	18,802	18,802
Strains:	(5)	(298,474)	(59,695)*
WL vs Heavy breeds	1	67,051	67,051*
HL vs other WL	1	155,496	155,496**
GL vs DL	1	1,763	1,763
PR vs other Heavy breeds	1	70,380	70,380*
WR vs BA	1	3,782	3,782
Interaction	5	31,087	6,217 /1

/1 Significant at the .01 level as determined by chi-square analysis
** Significant at the .01 level
* Significant at the .05 level

Table 26. Average egg production per hen-housed from September 4 to April 1 in unstable intermingled and pure strain flocks.

Strains	Percentile Rank (unstable pens)	Unstable Interm.	Pure Strain	(UI-PS)
White Leghorn:				
GL	.63	53.5	51.8	1.7
DL	.56	50.0	51.8	-1.8
HL	.43	34.4	40.7	-6.3
Heavy breeds:				
WR	.56	45.5	44.8	.7
BA	.46	41.3	44.6	-3.3
PR	.29	29.1	39.7	-10.6

DISCUSSION

Significant correlations were found between social status within flocks and initial body weight, age at sexual maturity, gain in weight (Sept.-Dec.), feeding activity and survivor's percentage egg production (Sept.-Dec.) within strains. These findings are in accord with Sanctuary's (1932) investigations on egg production and with Collias' (1944) and Guhl's (1953) results showing that high ranking birds have priority for food and produce more eggs than lower ranking birds.

The lack of heterogeneity of correlations for the same strains in different social groups and for different strains indicates that the same

situation exists within strains in different social groups, i.e. higher ranking individuals within different strains and breeds tend to perform at higher levels no matter what type of social organization is present.

This study revealed definite strain and breed differences in aggressiveness and partially confirms earlier investigations of Potter (1949), Potter and Allee (1953) and Hale (1956). The work of these investigators suggested that a hen may respond to a member of a breed on the basis of breed recognition rather than that of individual recognition. Contrarily, in this experiment considerable variation within breeds in intermingled flocks was noticed, e.g. the GL were more aggressive than the BA, which were more aggressive than the HL, suggesting that the BA responded to members of the WL breed on the basis of individual recognition rather than that of breed recognition.

No measurable difference in productivity was noted when comparing the unstable and stable intermingled flocks, suggesting that the time at which different strains were assembled had little effect, if any, on the various items of productivity. When intermingled flocks were compared to pure strain flocks there was a non-significant tendency for the strains to do better from the September 4 to April 1 period in pure strain flocks.

Since the breeder or experiment station may want to compare the performance of birds of different genetic background it would appear desirable to intermingle these in the same pens to avoid environmental factors peculiar to specific pens which might raise or lower the productivity of any birds placed in such pens. On the other hand, if competition effects are present between strains, it would appear desirable to house different strains or breeds of birds separately, as a more accurate estimate of the less aggressive strains' potential productivity could be obtained in pure strain flocks. Such a system would probably require replication of strains in two or more

pens to overcome environmental differences between pens.

The results from this experiment indicate that strains or breeds should not be intermingled for short term performance tests as competition effects were involved when gains in weight, feeding activity and survivor's percentage egg production were considered. Competition effects were also involved in hen-housed egg production for the September 4 to April 1 period, indicating that the different strains were not adequately tested for production potential in intermingled flocks.

SUMMARY AND CONCLUSIONS

Positive, significant correlations were found to exist between the social status of individuals within a pen and September weight, feeding activity and survivor's percentage egg production from September through December on a within strain basis. A positive correlation that lacked significance was found between social status and survivor's percentage egg production for the September to April 1 period.

Negative, significant correlations were found to exist between the social status of individuals within a flock and gain in weight for the four-month period following housing, and age at sexual maturity. A negative correlation that lacked significance was found between social status and gain in weight for a seven-month period following housing.

The relative aggressiveness of different strains in intermingled flocks differed, depending on how old the birds were when the strains were assembled.

On the basis of results with three Leghorn and three heavy breed strains it appeared that within the White Leghorns and within the heavy breed strains there was a tendency for the higher ranking strains to weigh more initially, gain slightly less in weight after housing, mature earlier, have higher egg

production rates and less mortality.

The age at which the strains were assembled had no effect on gain in weight, feeding activity, sexual maturity, percentage mortality and survivor's percentage egg production from September 4 to April 1 (7 months).

Competition effects were indicated for the four-month period following housing (September through December) when survivor's percentage egg production, feeding activity and gains in weight were considered. Competition effects were also involved in hen-housed egg production for the September to April 1 period (7 months).

Competition effects were absent for date of sexual maturity. In considering the seven-month period after housing, competition effects were absent for survivor's percentage egg production and percentage mortality.

The results indicate that in order to get a more accurate estimate of how strains will perform, each strain should be housed separately rather than intermingled with other strains or breeds.

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THE SOCIAL STATUS AND ITEMS OF PRODUCTIVITY
IN THE DOMESTIC CHICKEN

by

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This investigation deals with the social hierarchy in the flock in association with items of productivity. Correlations between social status of the individual and sexual maturity, initial body weight, gain in weight, rate of feeding and egg production were obtained. The importance of social stability and inter-strain competition as effects on productivity were also studied.

Six pure strains of four breeds were used. All strains were hatched simultaneously. The chicks were raised in batteries until four weeks of age, then transferred to a brooder house. At eight weeks of age they were moved to the poultry range, with the exception of the socially "stable" population. The stable group, consisting of eight birds of each strain was reared together. The other flocks were considered as being "unstable" at time of housing since the pullets placed in them were in most cases strangers to each other.

The poultry house was divided into three "intermingled" pens (10'x16') each of which held 48 birds with eight birds representing each of the six strains. The house also had six "pure strain" pens (8'x10') each holding 24 pullets of the same strain.

The pullets were housed at five months of age at which time they were debeaked, weighed and identified by wing badges. After housing, the birds were trapnested three days per week and body weights were taken every 90 days. The pullets were observed for at least four hours per day, six days per week to determine the "peck-order" in each of the nine pens. Birds were ranked in the peck-order on the basis of the formula: rank of X = (A+B)/2 where: A = the percentage of birds in the pen that X dominated. B = 1.00 minus the percentage of birds in the pen dominating X. Feeding rates were obtained by observing each pen two hours per week in two one-hour periods

from September to December.

Positive, significant correlations were found to exist between the social status of individuals within a flock and initial September weight, feeding activity and survivor's egg production from September through December. Negative, significant correlations were found to exist for the social status of individuals within a flock with gain in weight for the four-month period following housing and also with age at sexual maturity.

In comparing stable vs unstable flocks it was found that strains differed in relative aggressiveness depending on how old the birds were when the strains were assembled together. The age at which the strains were assembled had no effect, however, on gain in weight, feeding activity, sexual maturity, percentage mortality and survivor's egg production from September through March.

Performance of strains in intermingled flocks differed from performance when not in competition with other strains for feeding activity, gains, survivor's egg production and hen-housed egg production for the first few months after housing. Competition effects decreased in importance for survivor's egg production when considered over a longer period (7 vs 4 months).

The results indicated that more accurate estimates of potential performance may be obtained if each strain is housed separately rather than intermingled with other strains or breeds. This appears to be of more importance for periods of four months or less following housing than when extended comparisons are involved.